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Nutrient Content of Grasses Growing on Four Range Sites in South Texas

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Nutrient Content of Grasses Growing on Four Range Sites in South Texas

By J. H. Everitt and M. A. Alaniz[1]

ABSTRACT

During the growing seasons of 1976 and 1977, abundant grasses from four range sites in south Texas were analyzed for crude-protein, P, Ca, Mg, K, and Na contents. All grasses were native, except buffelgrass, *Cenchrus ciliaris* Linnaeus. Levels of crude protein, P, and K were generally highest after periods of higher rainfall in late spring, summer, and early fall and lowest in late fall as the grasses became dormant; levels of Ca, Mg, and Na remained generally stable and showed little relationship to rainfall or date during the growing season. Levels of crude protein, Ca, Mg, and K were generally adequate for cattle requirements throughout the growing season on all four sites. Phosphorus contents of grasses were probably adequate for dry cows throughout the growing season on all sites but were generally below requirements of lactating cows. Sodium levels were generally below minimum requirements for beef cattle throughout the growing season on all sites. Index terms: beef cattle, calcium, cattle, cattle nutrition, crude protein, forage, grasses, magnesium, phosphorus, potassium, range, sodium, Texas.

INTRODUCTION

Performance of range beef cattle depends on the level of nutrients in the forage they consume. Forage nutrition levels should be at least minimal for maintenance, with greater amounts needed for growth and weight gain. The chemical composition of forage indicates its nutritive value; and chemical composition varies throughout the growing season, depending on stage of plant maturity, rainfall distribution, and drought (Cook and Harris 1950, Phillips et al. 1954, Nelson et al. 1970, Willard and Schuster 1973, Murray et al. 1978, Everitt et al. 1980). Knowing about these changes throughout the growing season will help ranchers to best use range forage and nutrient supplements.

This paper is part of a broad study on the chemical composition of grasses growing on a variety of range sites in south Texas. Results on other sites have been reported by Everitt et al. (1980, 1982). Our objectives in this study were to characterize the crude-protein and mineral composition of grasses growing on four range sites during the growing seasons (March through November) of 1976 and 1977 and to compare these results with nutrient levels recommended for beef cattle by the National Research Council (1976).

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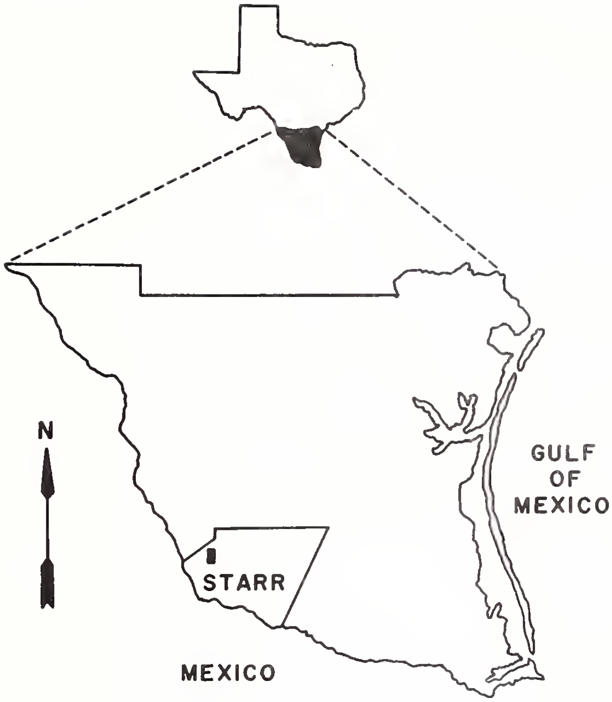

FIGURE 1.—Location of study area in Starr County, Tex.

STUDY AREA

This study was conducted on four range sites located about 20 km north of Roma, in Starr County, Tex. (fig. 1). The research area is located in the South Texas Plains vegetational region (Gould 1975). The area's climate is mild, with short winters and relatively warm temperatures throughout the year. The average length of the growing season is 305 days (U.S. National Oceanic and Atmospheric Administration 1976). Average annual rainfall is 43 cm and usually occurs in association with thunderstorms that are unevenly distributed both geographically and seasonally. Occasionally, tropical disturbances produce heavy rainfall; so September has the highest long-term monthly rainfall average, with another rainfall peak in May or June from squall-line thunderstorms. The rainfall is lowest in January or February.

The four range sites, as classified by Thompson et al, (1972), were: gray sandy loam, clay loam, Ramadero, and shallow ridge. The gray sandy loam site consists of Copita soils. The Copita series is a member of the fine-loamy, mixed, hyperthermic family of Ustollic Calciorthids. These are calcareous soils that have light brownish gray and grayish brown fine sandy loam A horizons, pale brown and light yellowish brown sandy clay loam B horizons, and very pale brown sandstone C horizons. The clay loam site consists of Garceno soils. The Garceno series is a member of the fine, mixed, hyperthermic family of Ustollic Camborthids. These soils have brownish loamy A horizons and friable, brownish clay loam B2 horizons, and C horizons containing about 2% visible segregations of lime. The Ramadero site is made up of the Ramadero soil series, a member of the fine-loamy, mixed, hyperthermic family of Cumulic Haplustolls. These soils have dark grayish brown sandy loam A horizons, pale brown sandy clay loam B2 horizons, and light yellowish brown sandy clay loam C horizons. The shallow ridge site consists of Zapata soils. They are well-drained gently sloping soils that are very shallow over caliche. The Zapata series is a member of the loamy-carbonatic, hyperthermic, shallow family of Ustollic Paleorthids. They have grayish or brownish loamy A horizons usually not more than 20 cm thick and C horizons of indurated to strongly cemented caliche. The caliche extends to a depth of several decimeters. This site is droughty because of the lack of moisture storage and rooting depth. The gray sandy loam and clay loam sites are in large uniform areas. The Ramadero sites are located in long and narrow upland drainageways and are common in the western half of the South Texas Plains. The shallow ridge sites are generally in small areas but are very common in south Texas; these sites occur along a line of broken uplands extending from Starr County through Bee County (Davis and Spicer 1965).

All four sites supported a variety of woody plants and warm-season perennial grasses. Also, several species of perennial forbs occurred on all four sites. Honey mesquite, *Prosopis glandulosa* Torrey, was the dominant woody species on the gray sandy loam, clay loam, and Ramadero sites. Other common species on these three sites were blackbrush acacia, *Acacia rigidula* Bentham; spiny hackberry, *Celtis pallida* Torrey; guayacan, *Porlieria angustifolia* (Engelmann) Gray; and lotebush, *Ziziphus obtusifolia* (Torrey and Gray) Gray. Pricklypear cactus, *Opuntia lindheimeri* Engelmann, was also common on these sites. Dominant woody species on the shallow ridge site were blackbrush acacia; guajillo, *Acacia berlandieri*

Bentham; Texas kidneywood, *Eysenhardtia texana* Scheele; and cenizo, *Leucophyllum frutescens* (Berlandier) I. M. Johnston.

METHODS

The most abundant grasses from each site were selected for chemical analyses. Six grass species were sampled from the gray sandy loam and clay loam sites. Since the gray sandy loam site had a large variety of grasses, we also sampled a composite of miscellaneous species from this site. Five grass species plus a composite of miscellaneous grasses were also sampled from the shallow ridge site. Four grass species were sampled from the Ramadero site. Grasses were sampled monthly during the growing seasons (March through November) of 1976 and 1977.

The six grasses collected from the gray sandy loam site were buffelgrass, *Cenchrus ciliaris* Linnaeus; pink pappusgrass, *Pappophorum bicolor* Fournier; sand dropseed, *Sporobolus cryptandrus* (Torrey) Gray; Texas bristlegrass, *Setaria texana* W. H. P. Emery; hooded windmillgrass, *Chloris cucullata* Bischoff; and red grama, *Bouteloua trifida* Thurber. The six grasses collected from the clay loam site were pink pappusgrass; buffelgrass; Texas bristlegrass; red grama; lovegrass tridens, *Tridens eragrostoides* (Vasey and Scribner) Nash; and slim tridens, *Tridens muticus* (Torrey) Nash. The five grasses collected from the shallow ridge site were sand dropseed; pink pappusgrass; hooded windmillgrass; red grama; and Arizona cottontop, *Digitaria californica* (Bentham) Henrard. The four species collected from the Ramadero site were buffelgrass; Texas bristlegrass, red grama; and four-flowered trichloris, *Trichloris pluriflora* Fournier. Red grama is usually considered an invader species on these sites. But its abundance and apparent use by livestock warranted determining its nutritive status. The other grasses are classified as having fair-to-good grazing values (Thompson et al. 1972). Except for buffelgrass, all species are native. Buffelgrass is well adapted to loamy soils in south Texas (Everitt and Cuellar 1976) and is commonly used in reseeding after mechanical brush removal. Because of its adaptability, buffelgrass can become a component of native vegetation if a seed source is available (Gonzalez and Dodd 1979.) Although all four study sites supported primarily native vegetation, buffelgrass was present on the gray sandy loam, clay loam, and Ramadero sites, and was apparently heavily used by livestock. The gray sandy loam and Ramadero sites were continuously grazed by cattle throughout the study, but the clay loam site was only intermittently grazed. The shallow ridge site was used mainly for winter and spring grazing. Range condition ranged from fair on the Ramadero and shallow ridge sites to poor on the gray sandy loam and clay loam sites.

Composited samples from 15 or more plants were randomly taken for each grass species at the end of each collection month from each site. Grasses were sampled from the same general area each month. The phenology of the various grasses at each sampling date is presented in tables 1–4. Whole-grass samples (both leaves and stems) were clipped 2 to 3 cm above ground, air-dried at 65° C for 48 hours, ground in a Wiley mill through a 1-mm-mesh screen, thoroughly mixed, and stored in sealed jars until analyzed.

Plant samples were analyzed for crude protein (N×6.25), P, Ca, Mg, K, and Na. Total N was determined by the Kjeldahl method (Peech et al. 1947). Levels of Ca, Mg, K, and Na were determined by atomic-absorption spectrometry (Boettner and Grunder 1968). Lanthanum oxide was added to Ca and Mg samples to reduce interference. Phosphorus was determined by the rapid-digestion method (Bolin and Stramberg 1944).

Nutrient data for Ca, Mg, K, and Na contents were grouped by seasons: spring (March to May), summer (June to August), and fall (September to November). Data for both years were combined; so each season had six sampling dates. The mean and standard deviation of these four minerals were determined for each species.

RESULTS AND DISCUSSION

Crude Protein

Among the grasses sampled from the gray sandy loam, clay loam, and Ramadero sites, Texas bristlegrass had the highest crude-protein content, while buffelgrass generally

(*Continued on page 8.*)

Table 1.—Phenology of grasses at each sampling date on the gray sandy loam site

Grass species and year	Stage of maturity								
	March	April	May	June	July	August	September	October	November
Buffelgrass:									
1976	Vegetative	Vegetative	Vegetative & immature.	Mature	Mature	Mature	Immature	Mature	Dormant.
1977	Vegetative	Vegetative & immature.	Mature	Immature	Mature	Mature	Immature	Mature	Dormant.
Hooded windmillgrass:									
1976	Vegetative	Immature	Immature	Mature	Immature	Mature	Vegetative & immature.	Mature	Mature.
1977	Vegetative	Immature	Immature & mature.	Vegetative & immature.	Immature	Immature & mature.	Vegetative & immature.	Mature	Dormant.
Pink pappusgrass:									
1976	([1])	Early vegetative.	Vegetative	Immature	Vegetative & immature.	Mature	Immature	Mature	Mature.
1977	Vegetative	Vegetative & immature.	Immature & mature.	Immature	Vegetative	Immature	Vegetative & immature.	Late mature.	Dormant.
Red grama:									
1976	Vegetative	Vegetative & immature.	Immature	Mature	Vegetative & immature.	Mature	Immature	Mature	Mature.
1977	Vegetative	Immature	Mature	Vegetative & immature.	Mature	Mature	Immature	Mature	Mature.
Sand dropseed:									
1976	Early vegetative.	Vegetative	Immature	Immature	Immature & mature.	Mature	Vegetative & immature.	Mature	Dormant.
1977	Vegetative	Vegetative & immature.	Immature & mature.	Immature	Mature	Mature	Immature & mature.	Immature & mature.	Dormant.
Texas bristlegrass:									
1976	Vegetative	Vegetative & immature.	Immature	Immature	Immature & mature.	Mature	Immature & mature.	Mature	Mature.
1977	Vegetative & immature.	Immature	Mature	Immature	Vegetative & immature.	Immature & mature.	Immature	Mature	Mature.

[1]Insufficient plant development for sampling.

Table 2.—Phenology of grasses at each sampling date on the clay loam site

Grass species and year	Stage of maturity								
	March	April	May	June	July	August	September	October	November
Buffelgrass:									
1976	Early vegetative.	Vegetative	Immature	Mature	Immature & mature.	Mature	Immature	Mature	Dormant.
1977	Vegetative	Immature	Mature	Mature	Mature	Mature	Vegetative & immature.	Mature	Dormant.
Lovegrass tridens:									
1976	Early vegetative.	Vegetative	Vegetative	Immature	Mature	Mature	Vegetative & immature.	Mature	Mature.
1977	Vegetative	Vegetative	Vegetative & immature.	Mature	Immature	Mature	Vegetative	Mature	Late mature.
Pink pappusgrass:									
1976	Early vegetative.	Vegetative	Vegetative & immature.	Mature	Immature	Mature	Immature	Mature	Dormant.
1977	Vegetative	Vegetative	Vegetative	Vegetative & immature.	Mature	Immature & mature.	Immature	Mature	Dormant.
Red grama:									
1976	Early vegetative.	Vegetative & immature.	Vegetative & immature.	Mature	Vegetative & immature.	Mature	Immature	Mature	Dormant.
1977	Vegetative	Vegetative & immature.	Mature	Immature & mature.	Mature	Mature	Immature	Mature	Dormant.
Slim tridens:									
1976	Early vegetative.	Vegetative	Vegetative & immature.	Mature	Vegetative & immature.	Immature & mature.	Immature	Mature	Dormant.
1977	Vegetative	Vegetative	Immature	Immature & mature.	Mature	Immature & mature.	Immature & mature.	Mature	Dormant.
Texas bristlegrass:									
1976	Early vegetative.	Vegetative	Immature	Immature	Immature	Mature	Immature	Mature	Mature.
1977	Vegetative	Immature	Immature & mature.	Immature	Immature	Immature & mature.	Vegetative & immature.	Mature	Mature.

Table 3.—Phenology of grasses at each sampling date on the Ramadero site

Grass species and year	Stage of maturity								
	March	April	May	June	July	August	September	October	November
Buffelgrass:									
1976	Vegetative	Vegetative	Immature	Mature	Immature & mature.	Mature	Immature	Mature	Dormant.
1977	Vegetative	Immature	Mature	Immature	Mature	Immature & mature.	Immature	Mature	Dormant.
Four-flowered trichloris:									
1976	Early vegetative.	Vegetative	Immature	Mature	Immature	Mature	Vegetative & mature.	Mature	Late mature.
1977	Vegetative	Immature	Mature	Immature	Immature	Mature	Immature	Mature	Dormant.
Red grama:									
1976	Vegetative	Immature	Immature	Mature	Immature & mature.	Mature	Immature	Mature	Mature.
1977	Vegetative	Immature & mature.	Mature	Immature & mature.	Immature	Immature & mature.	Immature	Mature	Mature.
Texas bristlegrass:									
1976	Vegetative	Immature	Immature	Mature	Immature	Mature	Immature	Mature	Mature.
1977	Vegetative	Immature	Mature	Vegetative & immature.	Immature	Mature	Vegetative & immature.	Mature	Mature.

Table 4.—Phenology of grasses at each sampling date on the shallow ridge site

Grass species and year	Stage of maturity								
	March	April	May	June	July	August	September	October	November
Sand dropseed:									
1976	Early vegetative.	Vegetative	Vegetative & immature.	Immature	Mature	Mature	Immature & mature.	Mature	Dormant.
1977	Vegetative	Vegetative	Immature	Mature	Mature	Mature	Vegetative & immature.	Mature	Dormant.
Pink pappusgrass:									
1976	Vegetative	Vegetative	Immature	Mature	Vegetative & mature.	Mature	Immature & mature.	Mature	Mature.
1977	Vegetative	Vegetative & immature.	Immature & mature.	Mature	Vegetative & immature.	Mature	Vegetative & immature.	Mature	Dormant.
Arizona cottontop:									
1976	Early vegetative.	Vegetative	Immature	Mature	Immature & mature.	Mature	Vegetative & immature.	Mature	Dormant.
1977	Vegetative	Vegetative	Vegetative & immature.	Immature & mature.	Mature	Mature	Vegetative & immature.	Mature	Dormant.
Hooded windmillgrass:									
1976	Vegetative & immature.	Immature & mature.	Vegetative & mature.	Mature	Vegetative & immature.	Mature	Immature	Mature	Dormant.
1977	Immature	Mature	Mature	Immature & mature.	Mature	Mature	Vegetative & immature.	Mature	Dormant.
Red grama:									
1976	Early vegetative.	Vegetative & immature.	Mature	Vegetative & mature.	Immature & mature.	Mature	Immature	Mature	Dormant.
1977	Vegetative & immature.	Immature	Mature	Mature	Immature & mature.	Mature	Vegetative & immature.	Mature	Dormant.

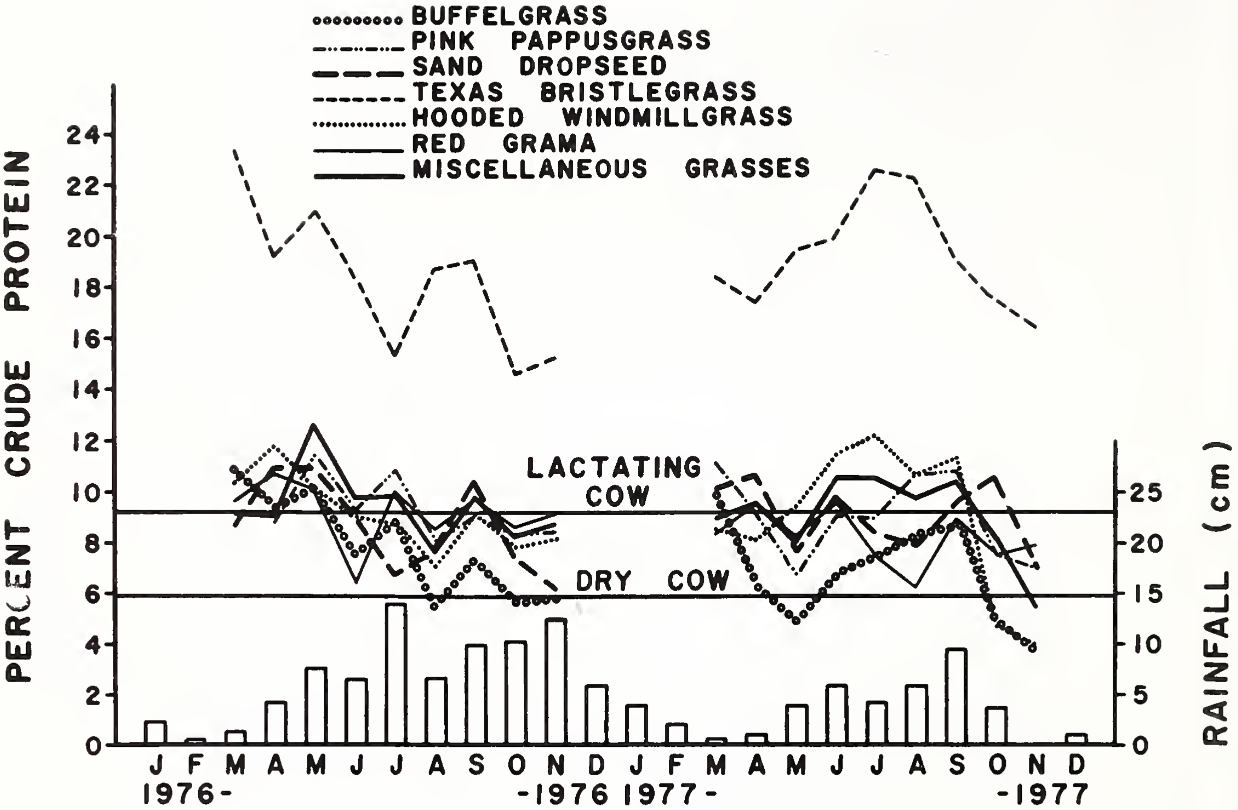

FIGURE 2.—Monthly (March-November) crude-protein content of six grass species and a composite of miscellaneous grasses growing on the gray sandy loam site during the growing seasons of 1976 and 1977. Horizontal lines represent protein requirements for dry and lactating cows.

had the lowest (figs. 2-4). Texas bristlegrass generally had twice as much crude protein as the other species. Since it grows almost exclusively under trees and shrubs, shading may enhance its crude-protein content. (McEwen and Dietz reported in 1965 that grasses growing in shade had more crude protein than did those growing in open areas.) On the shallow ridge site, hooded windmillgrass and pink pappusgrass generally had the highest crude-protein levels, and red grama had the lowest (fig. 5).

Trends in crude-protein levels of grasses from all four sites were similar. Grasses were generally highest in crude protein after higher rainfall periods during late spring, summer, and early fall, and lowest during late fall as the grasses went into dormancy or after periods of lower rainfall and higher summer temperatures. These results generally agreed with those reported in other south Texas studies (Varner and Blankenship 1978; Everitt et al. 1980, 1982). Although rainfall during the 1977 growing season was about one-half that of the 1976 growing season, crude-protein levels in grasses from all four sites did not vary greatly between the 2 years.

The protein requirements of beef cattle are 5.9% of the dry ration for dry cows and 9.2% for lactating cows (National Research Council 1976). In general, grasses from all four sites contained adequate levels of crude protein for dry cows throughout the growing season of both years; however, crude-protein levels of several species were often below the requirements of lactating cows (figs. 2-5). But livestock can choose better forage than what is hand-clipped by researchers (Cook et al. 1948, Weir and Torell 1959, Van Dyne and Torell 1964); Bredon et al. (1967) reported that the forage selected by esophageal-fistulated cattle had 66% more crude-protein than did hand-collected samples. Also, several woody plants and forbs were available to cattle on these sites: these plants may contribute large amounts of protein during stress periods (Cook and Harris 1950, Wilson 1969). And chemical analyses were based on

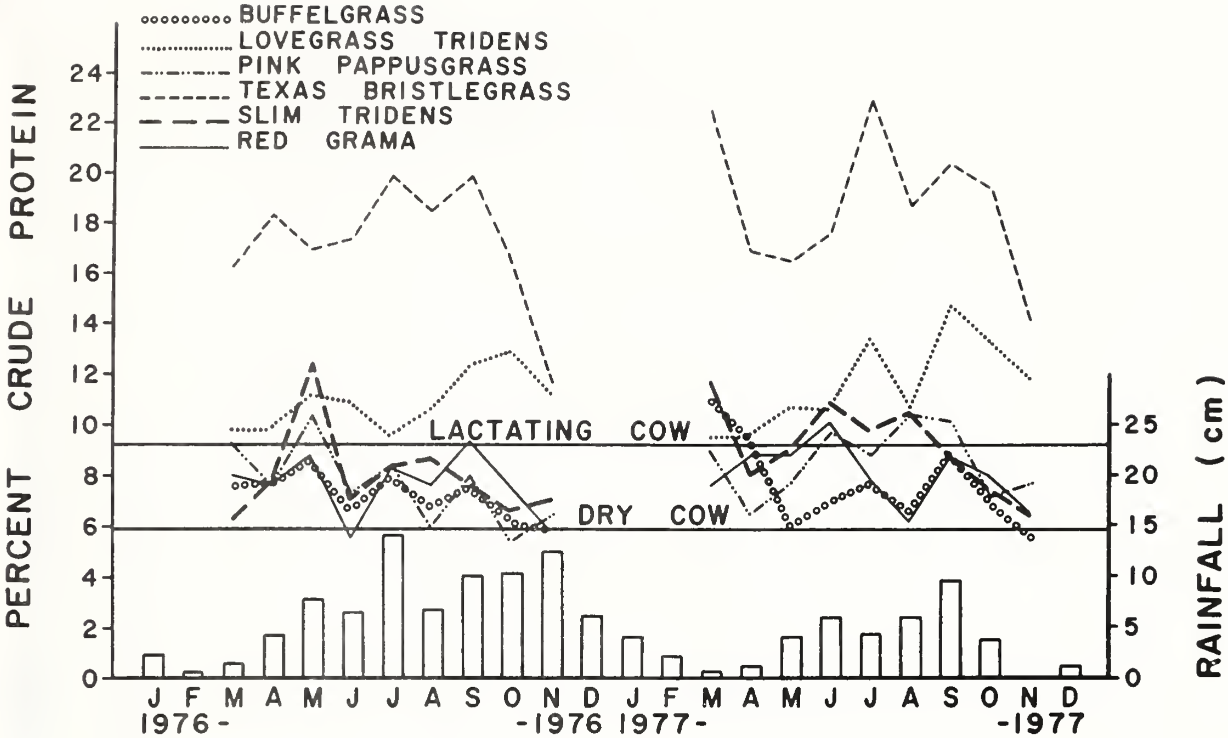

FIGURE 3.—Monthly (March-November) crude-protein content of six grass species growing on the clay loam site during the growing seasons of 1976 and 1977. Horizontal lines represent protein requirements for dry and lactating cows.

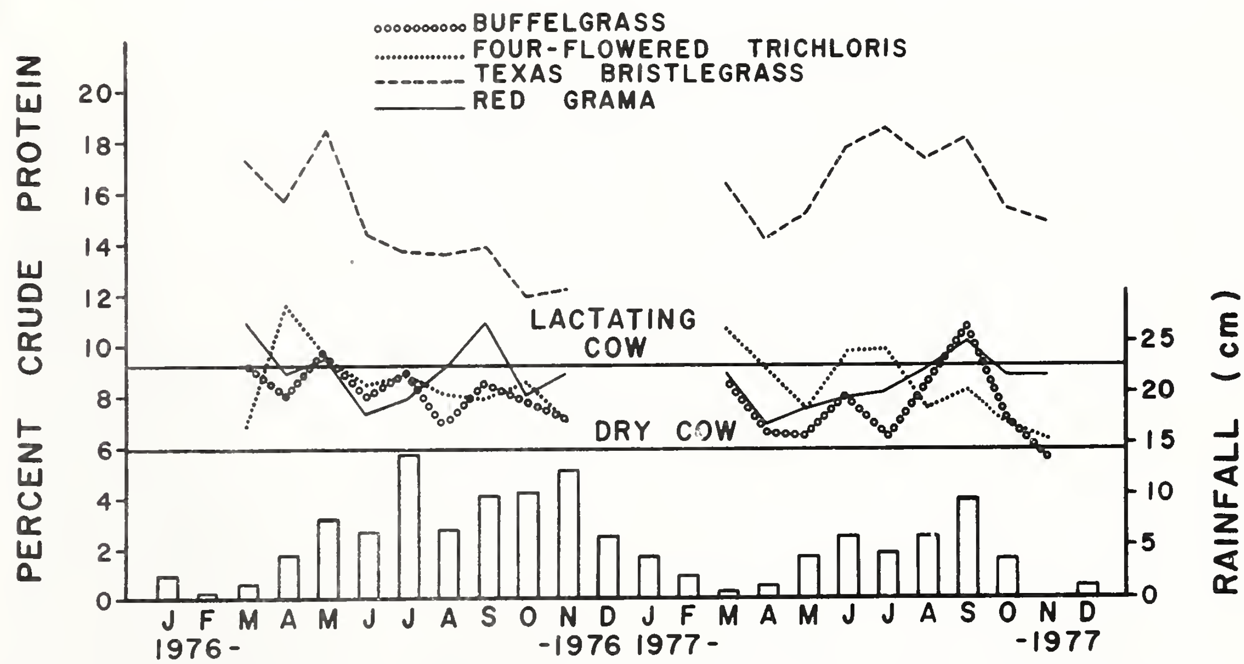

FIGURE 4.—Monthly (March-November) crude-protein content of four grass species growing on the Ramadero site during the growing seasons of 1976 and 1977. Horizontal lines represent protein requirements for dry and lactating cows.

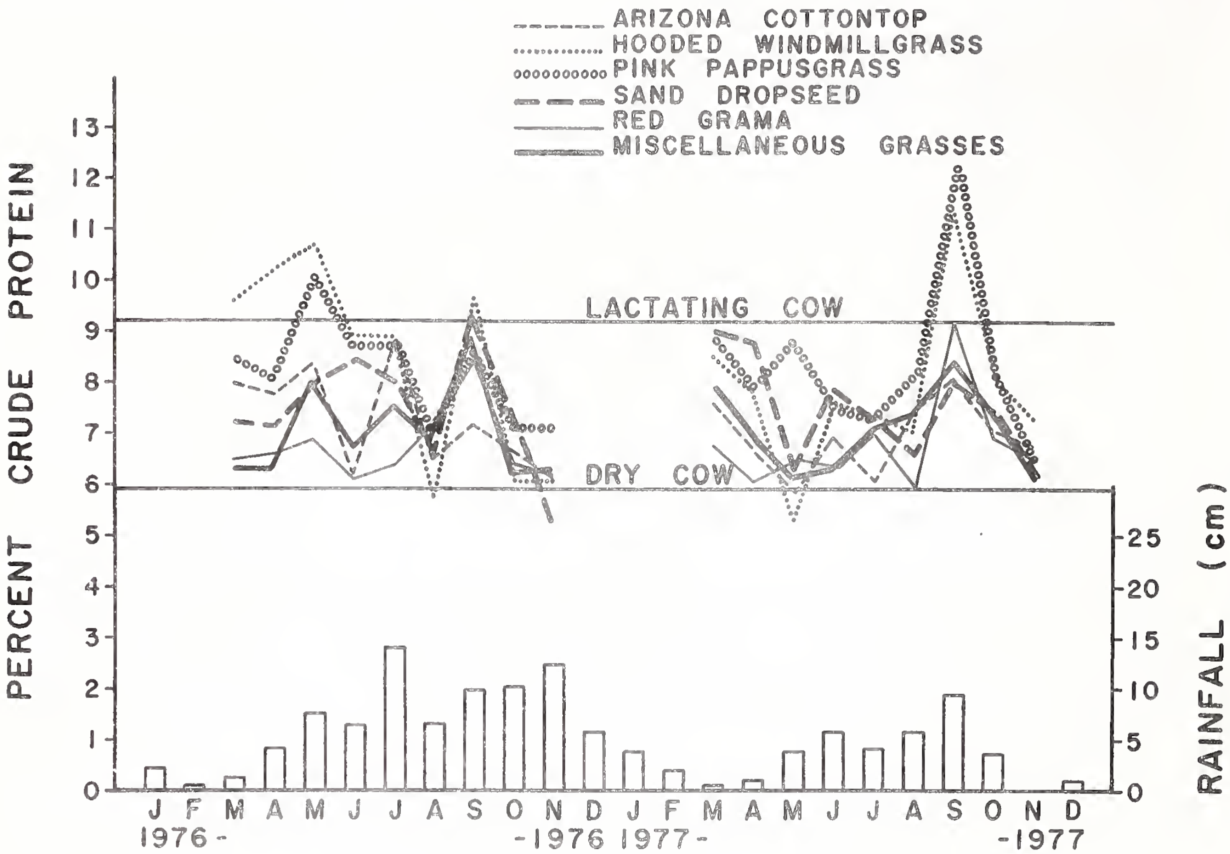

FIGURE 5.—Monthly (March–November) crude-protein content of five grass species and a composite of miscellaneous grasses growing on the shallow ridge site during the growing seasons of 1976 and 1977. Horizontal lines represent protein requirements for dry and lactating cows.

whole-grass samples (both leaves and stems); grass leaves have higher crude-protein contents than stems (Polk et al. 1976). So cattle probably obtain enough protein from forage throughout the growing season on these sites. But managers should consider protein supplementation in winter, since crude-protein levels in most grasses decrease below requirement levels during dormancy (Rogers and Box 1967, Willard and Schuster 1973, Everitt et al. 1980).

Phosphorus

Buffelgrass and Texas bristlegrass generally had the highest P contents among the grasses sampled from the gray sandy loam, clay loam, and Ramadero sites, and red grama generally had the lowest (figs. 6–8). Phosphorus levels varied greatly among the species sampled from the shallow ridge site but were generally highest in hooded windmillgrass and often lowest or nearly lowest in red grama (fig. 9).

Phosphorus levels of grasses followed the same general trend as crude-protein levels, being highest after higher rainfall periods during the growing season and lowest during the late fall or periods of lower rainfall and higher temperatures in summer. These data closely agree with those reported for grasses growing on saline range sites in south Texas (Everitt et al. 1982). Grasses from the shallow ridge site had consistently lower P levels than did grasses from the gray sandy loam, clay loam, and Ramadero sites for both years of the study.

The dry-cow P requirement is 0.18% of the dry ration; the requirement for lactating cows depends on a variety of factors and ranges from 0.18% to 0.39% of the dry ration (National Research Council 1976.) Based on these standards, several grasses from the gray sandy loam,

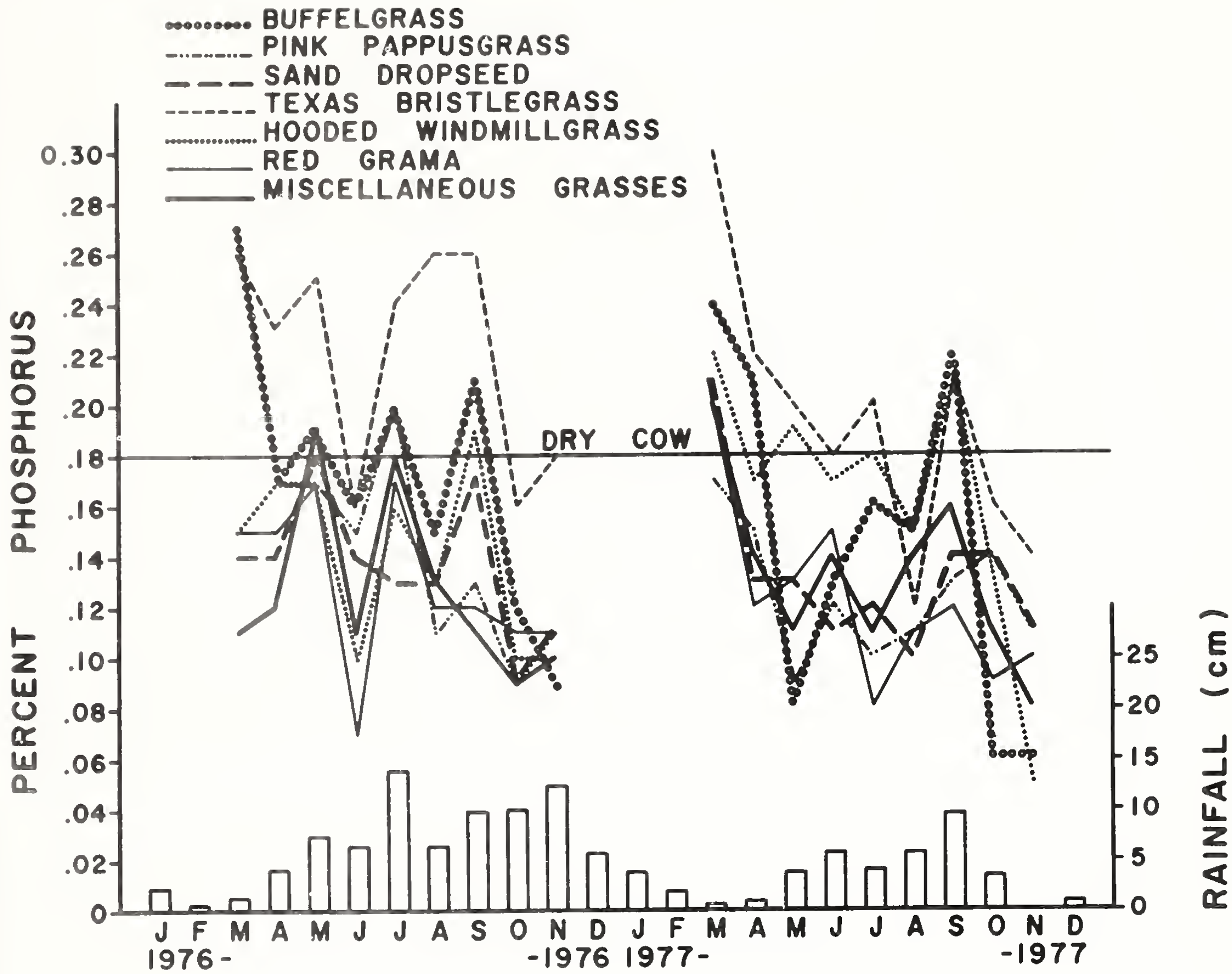

Figure 6.—Monthly (March-November) phosphorus content of six grass species and a composite of miscellaneous grasses growing on the gray sandy loam site during the growing seasons of 1976 and 1977. The horizontal line represents the phosphorus requirement for dry cows.

clay loam, and Ramadero sites had P levels that often met or nearly met the dry-cow P requirements (figs. 6–8). None of the grasses from the shallow ridge site had P levels considered adequate for dry cows (fig. 9). Phosphorus levels in grasses from all sites were probably inadequate for lactating cows, even though buffelgrass and Texas bristlegrass from the gray sandy loam, clay loam, and Ramadero sites often had P levels in the required range.

Since they can select quality forage, cattle grazing the grasses we analyzed would probably ingest more P than our data indicated. And they had a variety of other available forage plants that might add P to their diets. So P levels were probably adequate for dry cows throughout most of the growing season on all four sites. But each site should probably be supplemented with P throughout the year to prevent a deficiency in lactating cows.

Calcium

The Ca requirement of beef cattle depends on a variety of factors and ranges from 0.18% to 0.44% of the dry ration (National Research Council 1976). The Ca requirements of dry and lactating cows do not differ. Throughout our study, all the grasses from each of the four sites had Ca levels above the minimum beef cattle requirements (table 5). Average Ca levels

(*Continued on page 15.*)

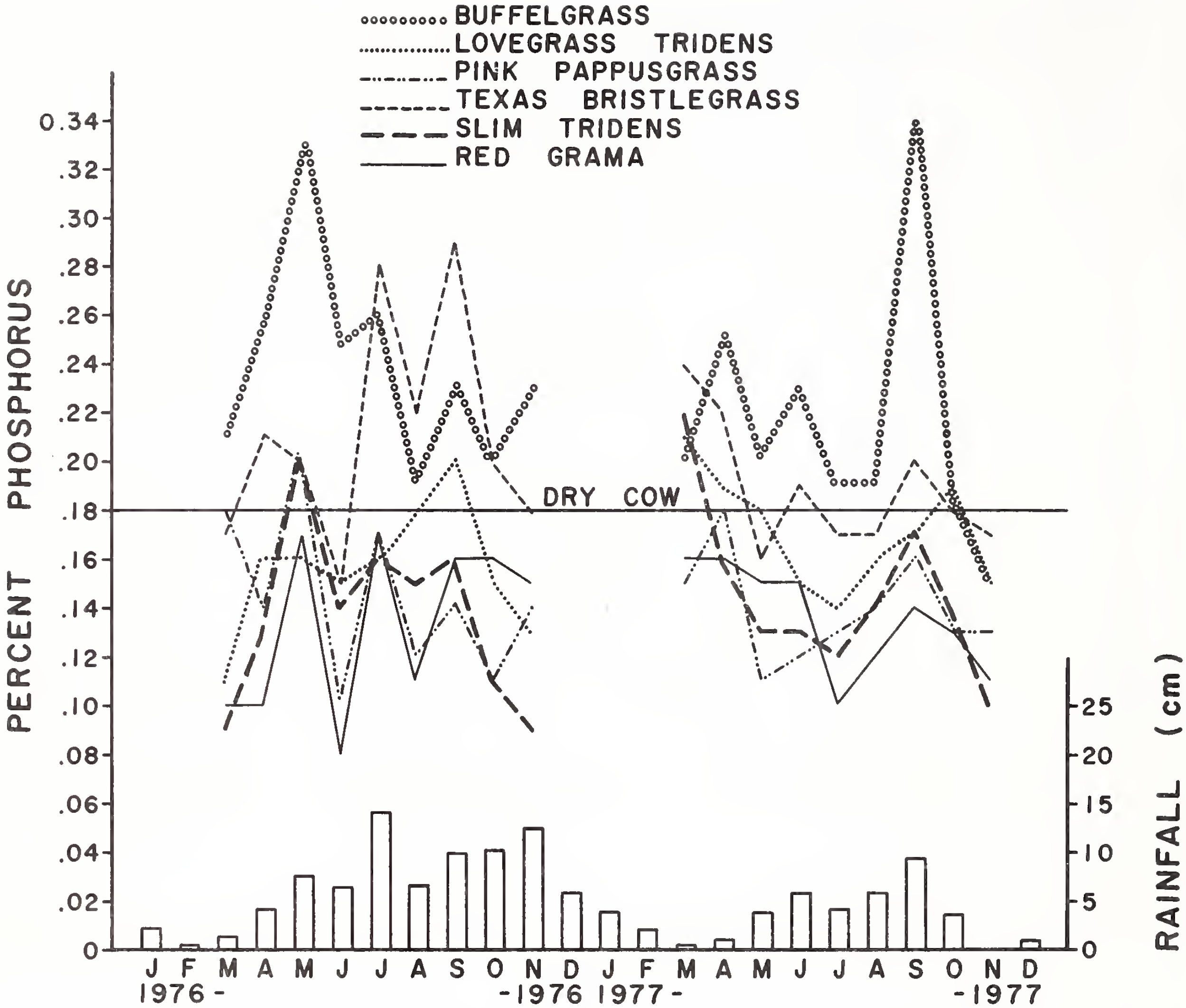

FIGURE 7.—Monthly (March-November) phosphorus content of six grass species growing on the clay loam site during the growing seasons of 1976 and 1977. The horizontal line represents the phosphorus requirement for dry cows.

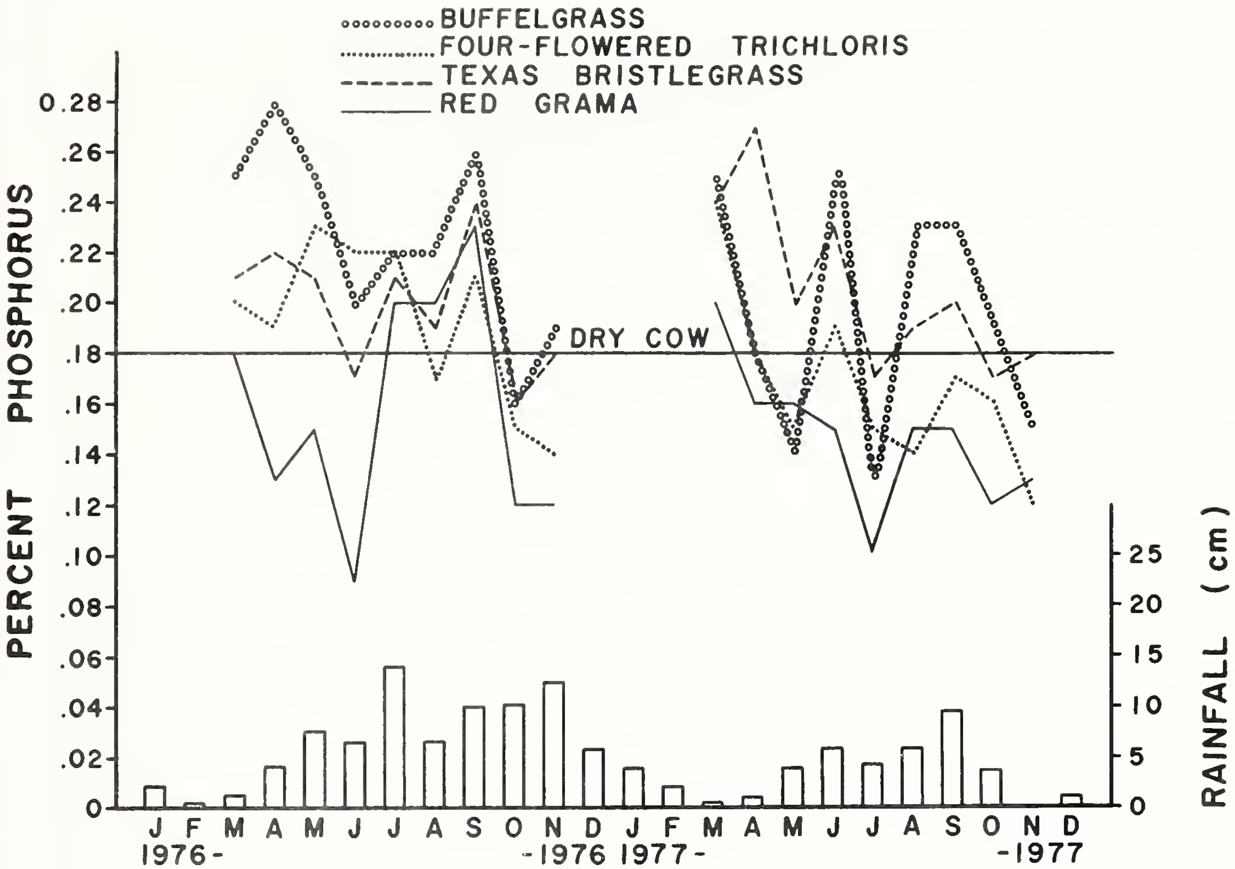

FIGURE 8.—Monthly (March–November) phosphorus content of four grass species growing on the Ramadero site during the growing seasons of 1976 and 1977. The horizontal line represents the phosphorus requirement for dry cows.

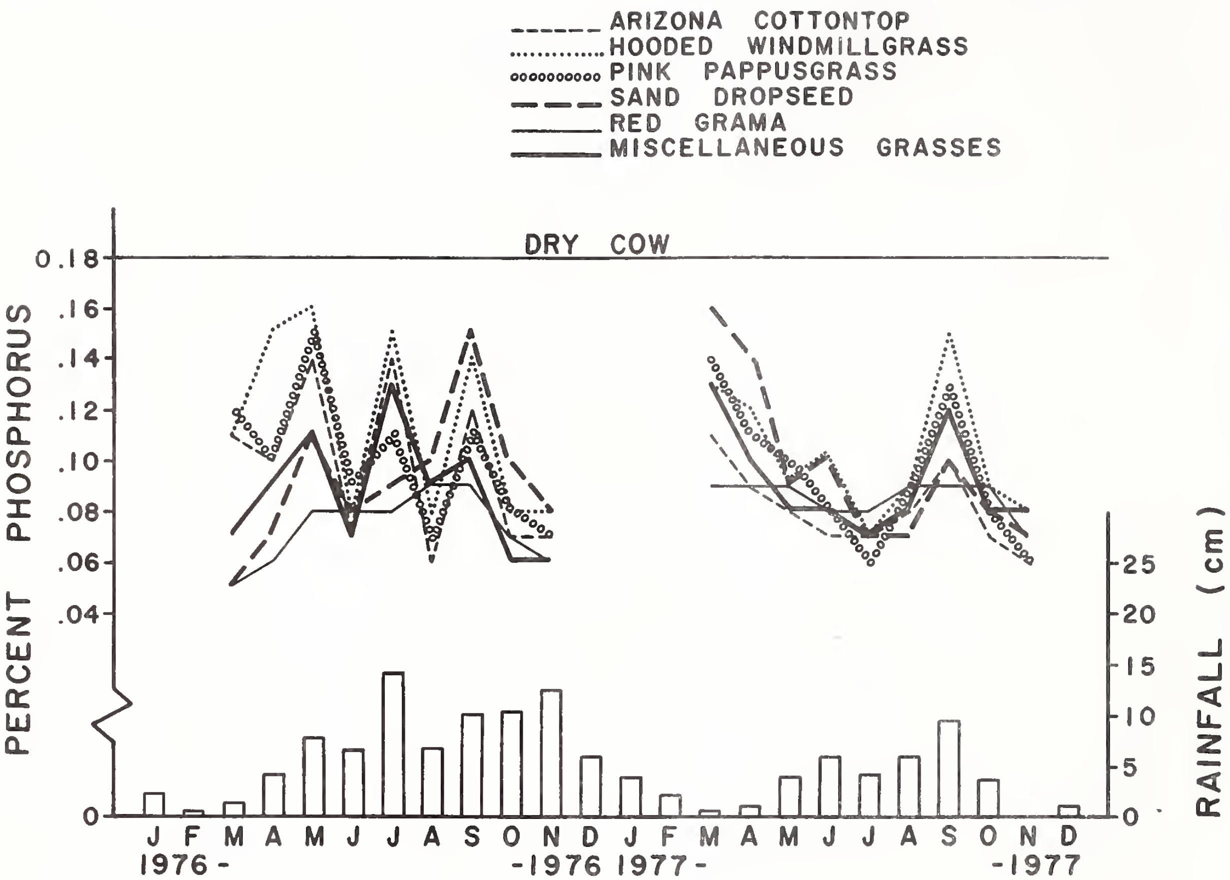

FIGURE 9.—Monthly (March-November) phosphorus content of five grass species and a composite of miscellaneous grasses growing on the shallow ridge site during the growing seasons of 1976 and 1977. The horizontal line represents the phosphorus requirement for dry cows.

Table 5.—Calcium content (percentage of dry matter) of range grasses growing on four sites during 1976 and 1977

Site and species	Spring		Summer		Fall		Mean
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	
Gray sandy loam site:							
Buffelgrass	0.67	0.14	0.70	0.11	0.62	0.07	0.66
Pink pappusgrass	.60	.12	.54	.09	.53	.11	.56
Sand dropseed	.64	.16	.65	.15	.46	.07	.58
Texas bristlegrass	.65	.16	.80	.10	.76	.11	.74
Hooded windmillgrass	.69	.18	.72	.13	.58	.09	.66
Red grama	.68	.12	.81	.07	.58	.10	.69
Miscellaneous grasses	.64	.10	.69	.10	.62	.07	.65
Mean	.65	....	.70	....	.59	....	......
Clay loam site:							
Buffelgrass	0.69	0.11	0.70	0.14	0.65	0.12	0.68
Lovegrass tridens	1.12	.24	1.05	.23	1.11	.21	1.09
Pink pappusgrass	.56	.07	.58	.18	.53	.15	.56
Texas bristlegrass	.72	.17	.77	.12	.62	.11	.70
Slim tridens	.63	.15	.80	.12	.62	.06	.68
Red grama	.60	.13	.70	.14	.59	.13	.63
Mean	.72	....	.77	....	.69	....	......
Ramadero site:							
Buffelgrass	0.70	0.08	0.71	0.15	0.61	0.11	0.67
Four-flowered trichloris	.57	.07	.55	.08	.51	.07	.54
Texas bristlegrass	.77	.09	.76	.14	.69	.13	.74
Red grama	.65	.14	.69	.13	.65	.12	.66
Mean	.67	....	.68	....	.62	....	......
Shallow ridge site:							
Sand dropseed	0.62	0.07	0.55	0.11	0.54	0.08	0.57
Pink pappusgrass	.65	.11	.58	.07	.54	.09	.59
Arizona cottontop	.68	.08	.76	.14	.71	.17	.71
Hooded windmillgrass	.79	.05	.90	.13	.80	.18	.83
Red grama	.53	.04	.53	.10	.52	.10	.53
Miscellaneous grasses	.60	.12	.62	.05	.61	.08	.61
Mean	.65	....	.66	....	.62	....	......

ranged from 0.53% in red grama on the shallow ridge site to 1.09% in lovegrass tridens on the clay loam site. Except for a slight decline in the Ca content of several species during the fall, Ca levels of grasses were generally not affected by either season of year or rainfall. These data generally agreed with those reported in other studies in New Mexico and south Texas (Nelson et al. 1970; Everitt el al. 1980, 1982).

Calcium:Phosphorus Ratios

Maynard and Loosli (1969) reported that ruminants need a Ca:P ratio of about 2:1 to insure proper intestinal mineral absorption. Dukes (1955) found that this ratio could be wider if the vitamin D supply was adequate. None of the grasses in this study had a Ca:P ratio of 2:1, but several had 3:1 and 4:1 ratios. Grasses from the shallow ridge site had wider Ca:P ratios than did grasses from the other three sites. But Ca:P ratios in grasses from all sites were probably adequate because of selective grazing by cattle and the presence of an adequate supply of vitamin D throughout most of the year.

Magnesium

Mean Mg levels of grasses ranged from 0.09% in red grama on the shallow ridge site to 0.24%

Table 6.—Magnesium content (percentage of dry matter) of range grasses growing on four sites during 1976 and 1977

Site and species	Spring		Summer		Fall		Mean
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	
Gray sandy loam site:							
Buffelgrass	0.19	0.05	0.18	0.03	0.14	0.02	0.17
Pink pappusgrass	.20	.06	.19	.03	.17	.03	.19
Sand dropseed	.19	.04	.16	.04	.13	.03	.16
Texas bristlegrass	.24	.02	.25	.04	.24	.03	.24
Hooded windmillgrass	.14	.02	.14	.02	.11	.03	.13
Red grama	.12	.03	.14	.01	.09	.01	.12
Miscellaneous grasses	.16	.03	.17	.01	.15	.02	.16
Mean	.18	....	.18	....	.15	....	......
Clay loam site:							
Buffelgrass	0.16	0.03	0.15	0.03	0.15	0.02	0.15
Lovegrass tridens	.21	.03	.20	.02	.23	.04	.21
Pink pappusgrass	.16	.03	.14	.03	.12	.02	.14
Texas bristlegrass	.22	.05	.21	.03	.21	.03	.21
Slim tridens	.14	.05	.16	.02	.13	.03	.14
Red grama	.10	.03	.11	.02	.08	.02	.10
Mean	.17	....	.16	....	.15	....	......
Ramadero site:							
Buffelgrass	0.19	0.04	0.16	0.04	0.14	0.01	0.16
Four-flowered trichloris	.15	.02	.14	.01	.15	.01	.15
Texas bristlegrass	.21	.03	.22	.03	.21	.01	.21
Red grama	.11	.02	.11	.02	.11	.03	.11
Mean	.17	....	.16	....	.15	....	......
Shallow ridge site:							
Sand dropseed	0.15	0.06	0.12	0.03	0.12	0.01	0.13
Pink pappusgrass	.18	.03	.15	.02	.14	.03	.16
Arizona cottontop	.21	.05	.19	.04	.20	.02	.20
Hooded windmillgrass	.16	.02	.15	.03	.14	.04	.15
Red grama	.08	.02	.10	.03	.08	.02	.09
Miscellaneous grasses	.13	.04	.13	.02	.12	.02	.13
Mean	.15	....	.14	....	.13	....	......

in Texas bristlegrass on the gray sandy loam site (table 6). Except for a slight decline in the Mg content of a few species during the fall, Mg levels of grasses were generally stable throughout the growing season and showed little relationship to season or rainfall. Other workers have reported similar findings (Nelson et al. 1970, Munshower and Neuman 1978, Everitt et al. 1980).

The Mg requirement for dry cows has not been specifically determined but ranges from 0.04% to 0.10% of the dry ration; the requirement for lactating cows is 0.18% (National Research Council 1976). All the grasses analyzed from each of the four sites had adequate levels of Mg for dry cows throughout the growing season, and some species had Mg levels that met or nearly met the 0.18% level recommended for lactating cows. Although not all species contained adequate levels of Mg for lactating cows, cattle probably ingest adequate amounts of Mg through selective grazing and use of other forage plants available to them. Managers may want to consider Mg supplementation in winter to offset possible deficiency to lactating cows. Everitt et al. (1980) reported a substantial decrease in the Mg content of grasses during the dormant winter period.

Table 7.—Potassium content (percentage of dry matter) of range grasses growing on four sites during 1976 and 1977

Site and species	Spring		Summer		Fall		Mean
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	
Gray sandy loam site:							
Buffelgrass	2.89	0.69	2.32	0.43	1.91	1.18	2.37
Pink pappusgrass	1.76	.35	1.80	.51	1.35	.58	1.64
Sand dropseed	1.55	.30	1.32	.21	1.26	.46	1.38
Texas bristlegrass	3.23	.91	2.79	.66	2.53	.90	2.85
Hooded windmillgrass	1.77	.42	1.64	.30	1.39	.47	1.60
Red grama	.87	.15	.76	.29	.57	.13	.73
Miscellaneous grasses	1.29	.38	1.41	.28	1.21	.35	1.30
Mean	1.91	....	1.72	....	1.46	....	......
Clay loam site:							
Buffelgrass	2.61	0.58	1.75	0.40	2.15	0.91	2.17
Lovegrass tridens	1.66	.37	1.83	.34	1.77	.55	1.75
Pink pappusgrass	1.76	.28	1.58	.35	1.46	.58	1.60
Texas bristlegrass	2.84	.42	2.90	.76	2.71	1.17	2.81
Slim tridens	1.28	.66	1.36	.28	1.02	.28	1.22
Red grama	.75	.16	.70	.25	.71	.23	.72
Means	1.82	....	1.69	....	1.64	....	......
Ramadero site:							
Buffelgrass	2.63	0.83	2.28	0.39	2.14	0.62	2.35
Four-flowered trichloris	1.84	.41	1.71	.33	1.53	.29	1.69
Texas bristlegrass	2.93	.57	2.96	.74	2.72	.89	2.87
Red grama	.86	.13	.78	.15	.76	.26	.80
Mean	2.07	....	1.93	....	1.79	....	......
Shallow ridge site:							
Sand dropseed	1.12	0.18	1.11	0.23	1.01	0.33	1.08
Pink pappusgrass	1.74	.24	1.55	.26	1.33	.77	1.54
Arizona cottontop	1.24	.22	1.29	.47	1.28	.35	1.27
Hooded windmillgrass	1.46	.31	1.30	.38	1.40	.62	1.39
Red grama	.70	.23	.61	.11	.62	.19	.64
Miscellaneous grasses	.92	.16	.90	.22	.87	.26	.90
Mean	1.20	....	1.13	....	1.09	....	......

Potassium

The K content of grasses was quite variable among the species sampled from the four sites (table 7). Average K levels of grasses ranged from 0.64% in red grama on the shallow ridge site to 2.87% in Texas bristlegrass on the Ramadero site. Monthly trends in K levels resembled those for crude protein (figs. 2-5) and P (figs. 6-9)—they were highest after higher rainfall periods during the late spring, summer, and early fall, and lowest in late fall as the grasses became dormant. These findings generally agree with those reported in other south Texas studies (Everitt et al. 1980, 1982).

The K requirement for beef cattle has not been specifically determined, but it ranges from 0.60% to 0.80% of the dry ration; the K requirements of dry and lactating cows do not differ (National Research Council 1976). Except for red grama during the fall on the gray sandy loam site, all grasses from the four sites contained adequate levels of K throughout the growing season. Although the K content of grasses was adequate during the growing season, K probably should be supplemented in win-

Table 8.—Sodium content (percentage of dry matter) of range grasses growing on four sites during 1976 and 1977

Site and species	Spring		Summer		Fall		Mean
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation	
Gray sandy loam site:							
Buffelgrass	0.05	0.02	0.03	0.01	0.03	0.01	0.04
Pink pappusgrass	.04	.02	.03	.01	.03	.01	.03
Sand dropseed	.05	.03	.04	.02	.03	.01	.04
Texas bristlegrass	.13	.03	.12	.03	.08	.05	.11
Hooded windmillgrass	.09	.03	.09	.04	.07	.03	.08
Red grama	.03	.01	.02	.01	.02	.01	.02
Miscellaneous grasses	.03	.01	.03	.01	.03	.01	.03
Mean	.06	...	.05	...	.04	...	...
Clay loam site:							
Buffelgrass	0.05	0.03	0.03	0.01	0.03	0.01	0.04
Lovegrass tridens	.05	.02	.05	.02	.05	.02	.05
Pink pappusgrass	.03	.01	.02	.02	.02	.01	.02
Texas bristlegrass	.11	.03	.09	.04	.10	.04	.10
Slim tridens	.03	.01	.03	.01	.02	.01	.02
Red grama	.03	.01	.02	.01	.02	.01	.02
Means	.05	...	.04	...	.04	...	...
Ramadero site:							
Buffelgrass	0.05	0.02	0.03	0.01	0.02	0.01	0.03
Four-flowered trichloris	.02	.01	.02	.01	.02	.01	.02
Texas bristlegrass	.06	.02	.07	.02	.08	.02	.07
Red grama	.02	.01	.03	.01	.02	.01	.02
Mean	.04	...	.04	...	.04	...	...
Shallow ridge site:							
Sand dropseed	0.06	0.04	0.05	0.02	0.04	0.01	0.05
Pink pappusgrass	.02	.01	.03	.01	.03	.01	.03
Arizona cottontop	.04	.01	.05	.02	.03	.01	.04
Hooded windmillgrass	.07	.05	.07	.04	.05	.02	.06
Red grama	.02	.01	.02	.01	.02	.01	.02
Miscellaneous grasses	.02	.01	.02	.01	.02	.01	.02
Mean	.04	...	.04	...	.03	...	...

ter to maintain optimum performance of beef cattle. Other studies have shown that K levels in grasses drop below beef cattle requirements during winter (Nelson et al. 1970, Everitt et al. 1980).

Sodium

The minimum Na dietary requirement for both dry and lactating cows is 0.06% of the dry diet (National Research Council 1976). Except for hooded windmillgrass on the gray sandy loam and shallow ridge sites, and Texas bristlegrass on the gray sandy loam, clay loam, and Ramadero sites, none of the grasses had an adequate Na content for beef cattle (table 8). Except for Texas bristlegrass, which often increased in Na content after periods of high rainfall, the Na content of grasses remained relatively stable throughout the growing season. These data do not agree with results of other south Texas studies conducted on different range sites, where Na contents of grasses have generally been found to increase in the spring and after adequate rainfall during the growing season (Everitt et al. 1980, 1982). Our results do agree with those of studies conducted in New Mexico and Idaho that showed no relationship between season or rainfall and Na content of grasses (Nelson et al. 1970, Murray et al. 1978). Although the

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Na content of drinking water may help to supply cattle with Na, our findings substantiate the need for provision of common salt on these ranges.

CONCLUSIONS

These results are only suggestive and may be somewhat limited since data were collected from only one study area for each site. And the mineral qualities and quantities of the soils were not sampled. Recommendations for nutrient supplements to cattle are solely for consideration by ranchers and range managers. But, since the vegetation of the study areas was generally typical for each site (see Thompson et al. 1972), these data should provide a general index to the nutritional quality of comparable grass species growing on these and similar sites in south Texas and northern Mexico.

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